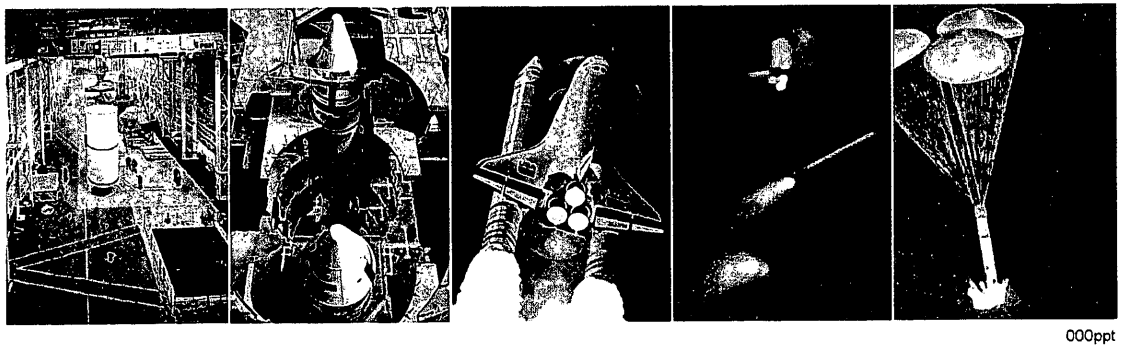
Automation of NDE on RSRM Metal Components

Presented by:

John Hartman, ATK Thiokol Propulsion
Mark Kirby, Westinghouse AMDATA



000ppt

ATK
ALLIANT TECHSYSTEMS

Thiokol Propulsion

Automation of NDE on RSRM components

Acknowledgements

The authors would like to acknowledge the following people and organizations for their contributions to this effort

Mike Suits	**Marshall Space Flight Center, NASA**
Craig Bryson	**Marshall Space Flight Center, NASA**
Scott Teunis	**Progressive Technologies, Inc.**
Dave Kay	**ATK Thiokol Propulsion**

Automation of NDE on RSRM components

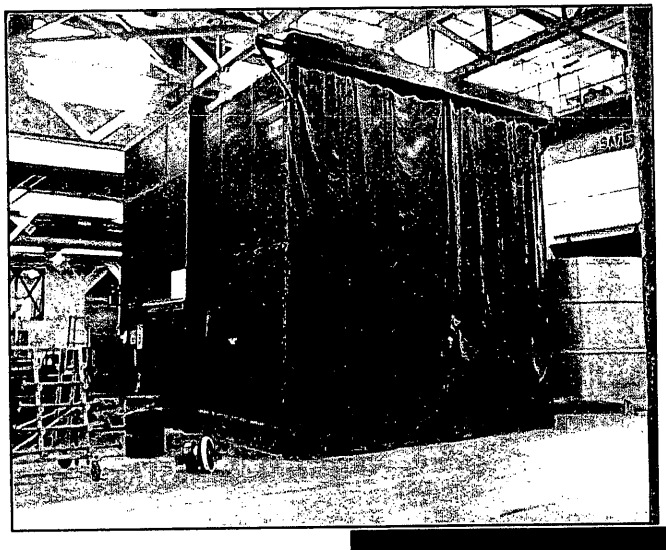
- Past NDE on RSRM metal components
- Why change?
- Advantages/Improvements
- Elements of Automated Inductive Inspection System
- Current Status

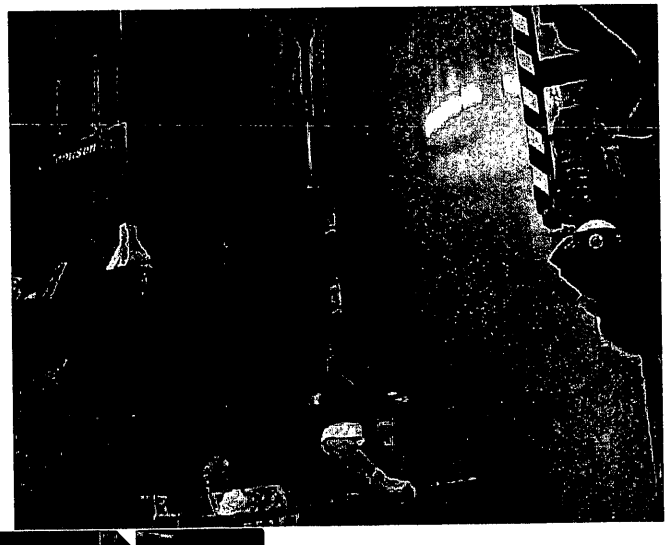
Past NDE on RSRM metal components

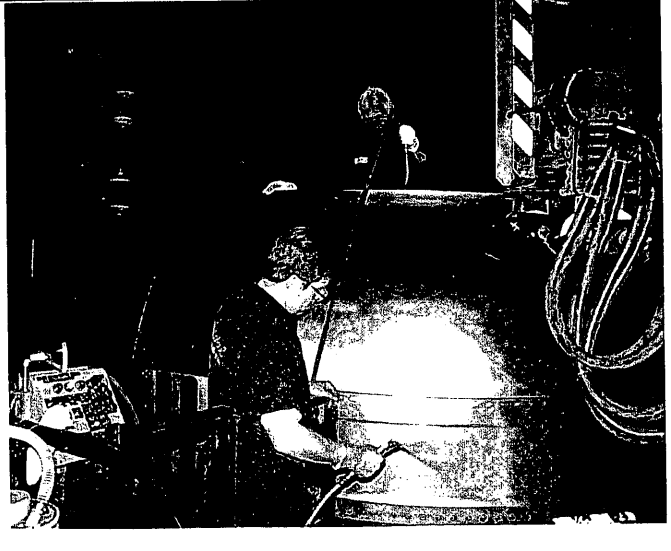
- Historically, nearly all NDE has been visually based
  - Magnetic particle inspection of steel components
  - Liquid penetrant of aluminum components
  - Semi-automated and manual eddy current inspections of select holes and joints
- Goal of inspections: detect surface cracks or discontinuities in both new and refurbished metal components

Past NDE on RSRM metal components

Case Magnetic Particle Inspection Bay



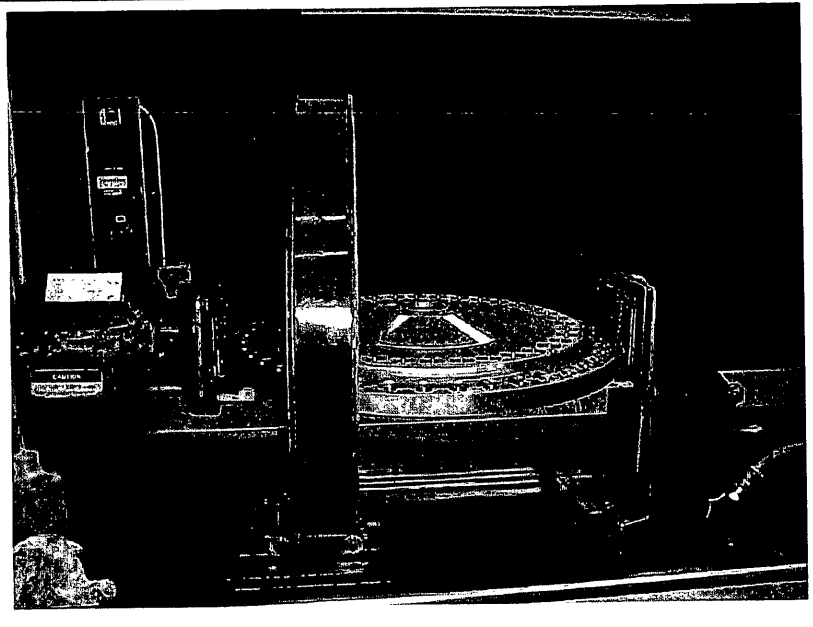




Past NDE on RSRM metal components

Past NDE on RSRM metal components

TSE Magnetic Particle Inspection Bay



Past NDE on RSRM metal components

WHY

CHANGE?

Why Change?

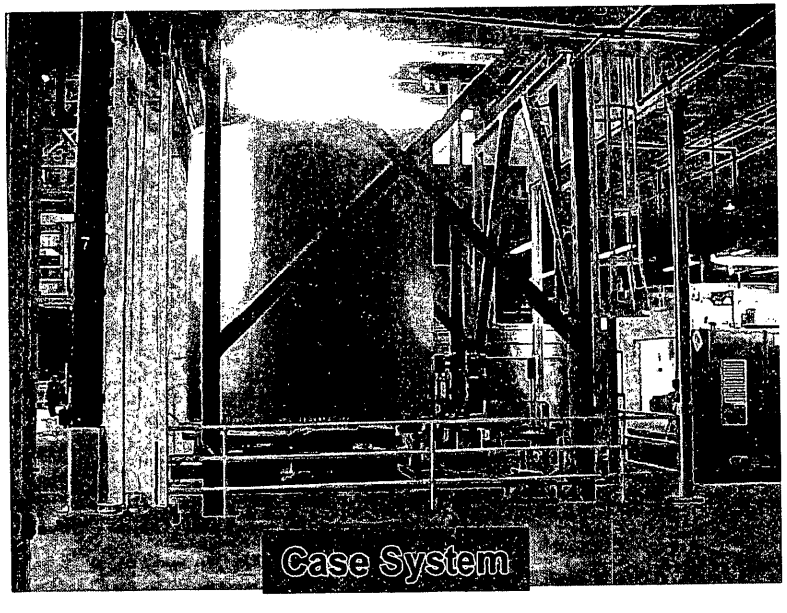
- Biggest Reason: ***Increase Reliability***
- **Reliability**: Assurance that critical sized flaws will not go undetected
- Remove the strong dependency on operator skill and attentiveness

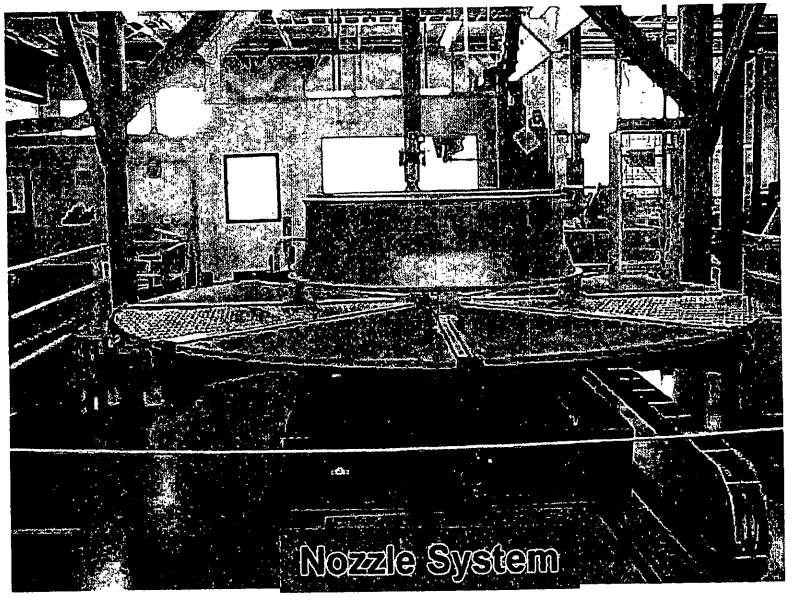
Why Change?

- Safe flight is certified by Proof Test, NDE, or both
- Based on in-house POD study, current magnetic particle inspections do not reliably screen for Critical Flaws in ALL regions
  - Minimum Detectable Flaw Size (90/95) > Critical Flaw Size
- These areas must be certified by proof and/or eddy current

Why Change?

- Solution:
- Implement an Automated Inductive Inspection System (AIIS) with the capability of reliably detecting critical sized surface flaws





Advantages of the AIIS

- ***Control & Repeatability***
  - Inspections, data acquisition & analysis are programmed
    - Same inspection & analysis each time
  - Detection sensitivity is calibrated
  - Pressure is no longer on the operator & his attentiveness

Advantages of the AIIS

- ***Better detection capability***
  - Overall, AIIS will find smaller flaws more reliably (at a 90%POD/95% CL)
    - Current sensitivity levels are set at 0.1" and 0.25" long cracks (2:1 length-to-depth ratio)

Advantages of the AIIS

- ***Data Storage***
  - All data and images are stored
    - This can be useful in developing history for a part and for determining the nature of flaws (manufacturing vs. service)

Advantages of the AIIS

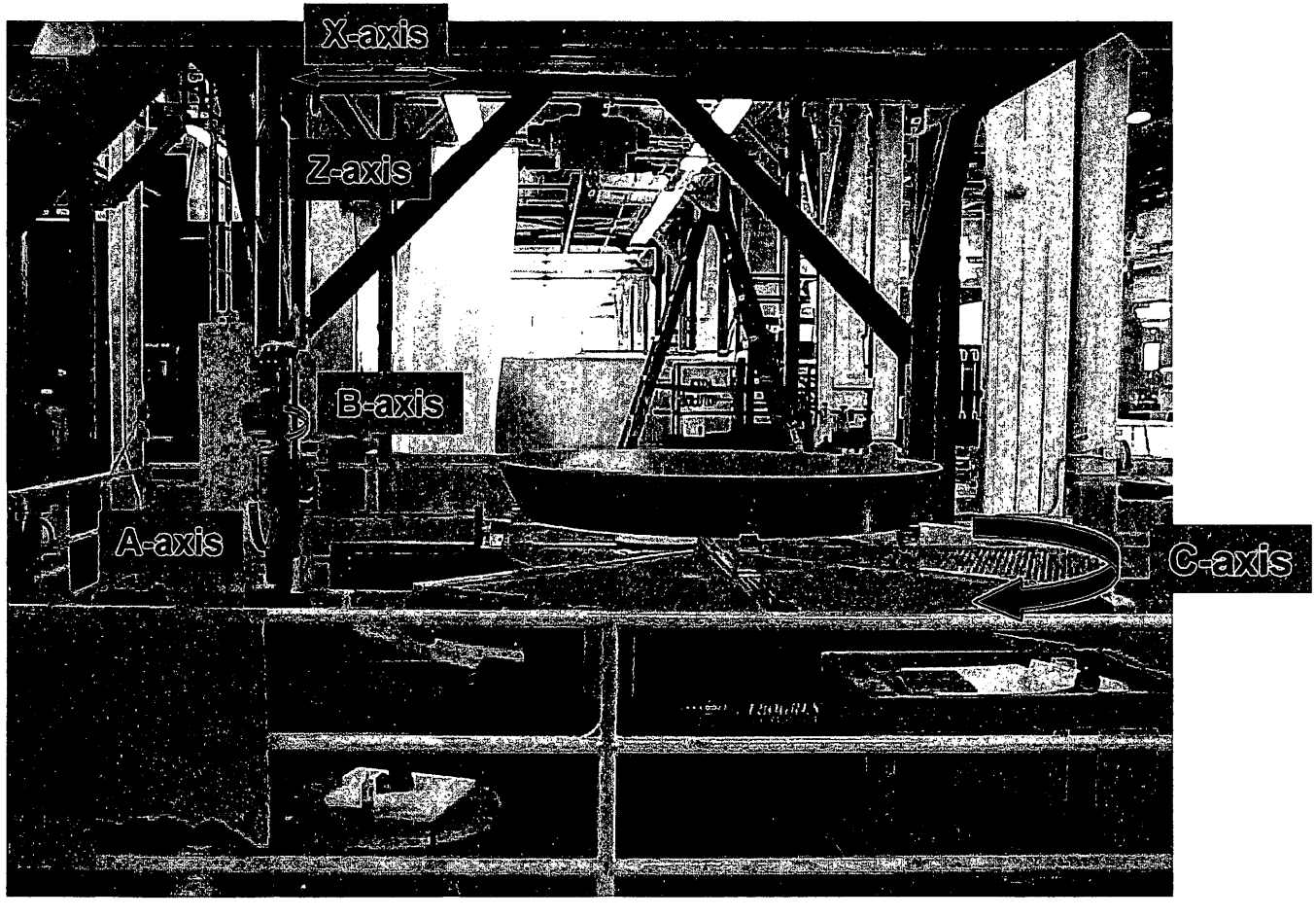
- ***Reduction of waste streams***
  - No solvents or chemicals to dispose of
  - Reduction or elimination of acid etch
    - Also extends lifetime of aluminum parts

Advantages of the AIIS

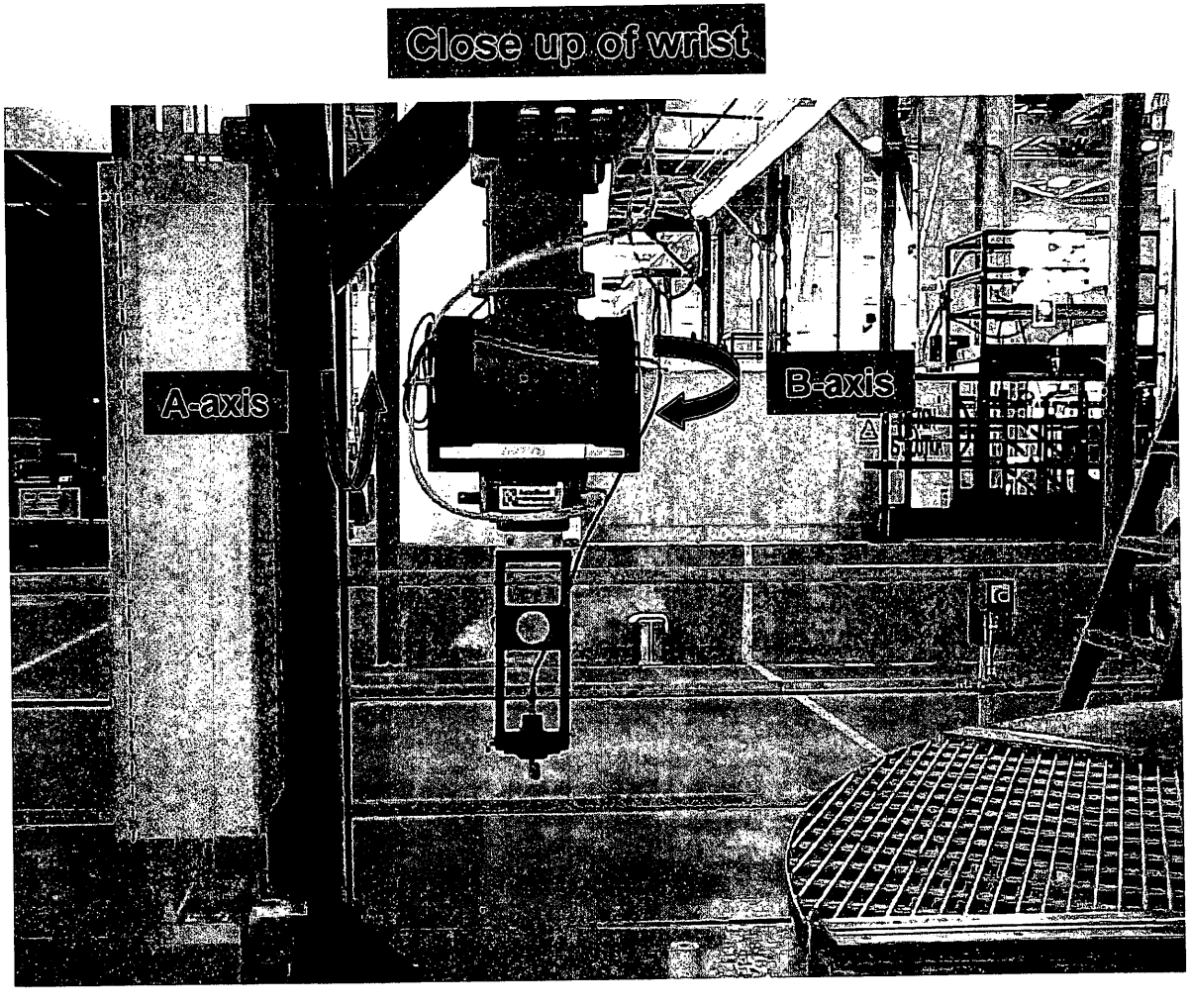
- ***Potential reduction of process time for Case Hardware and Aluminum Nozzle Hardware***
  - Possible elimination of acid etch process
  - Possible elimination of glass bead

Elements of AIIS

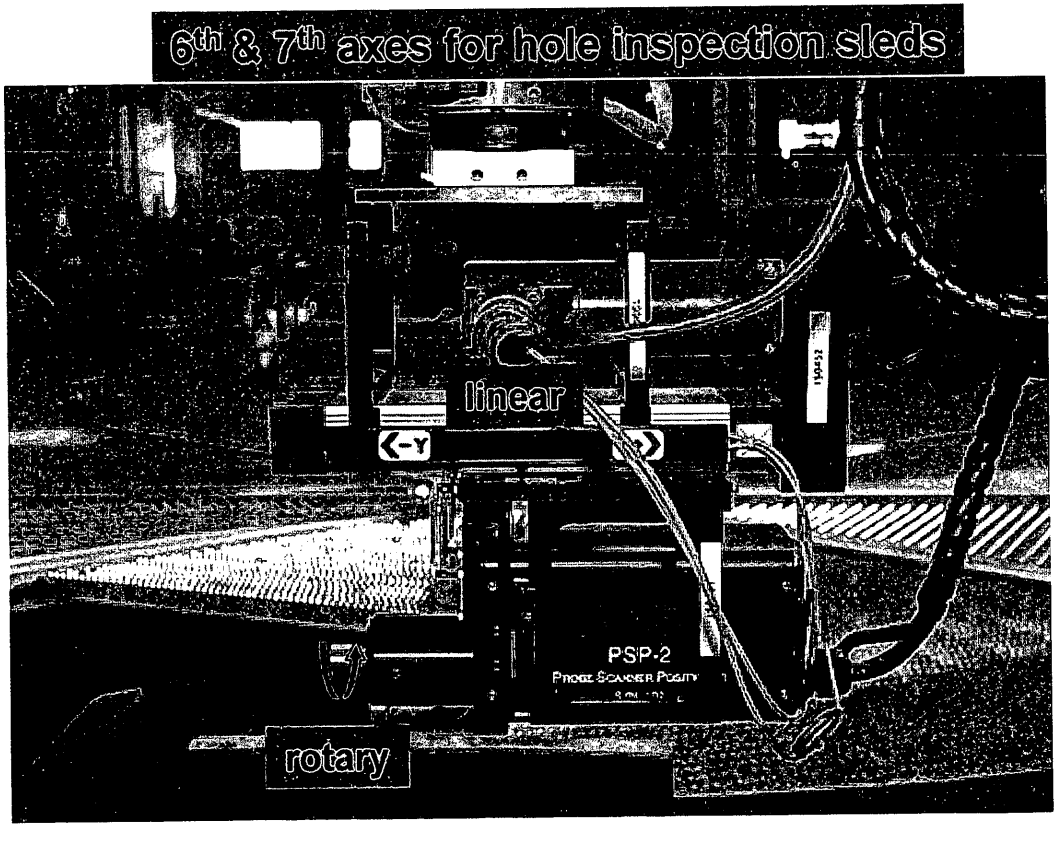
5 independent axes
7 axes when inspecting various holes



Elements of AIIS

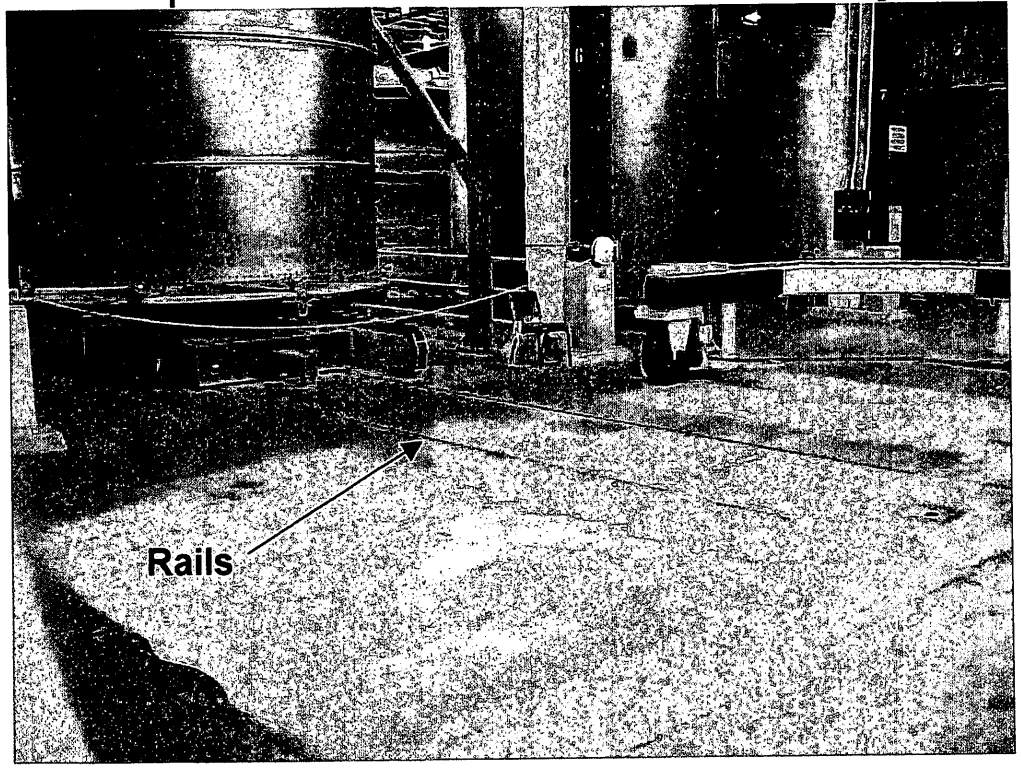


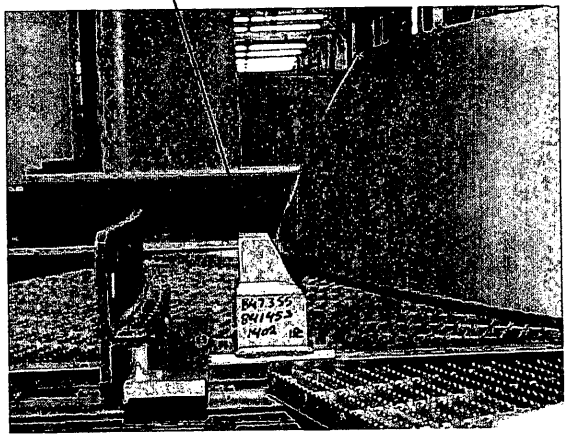
Elements of AIIS



Elements of AIIS

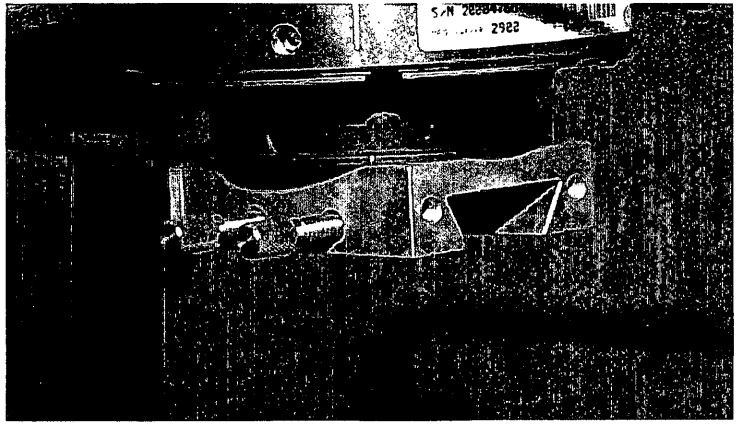
- Turntable is on rails, extends into high bay for loading and offloading of components
- Components are mounted on adjustable chocks

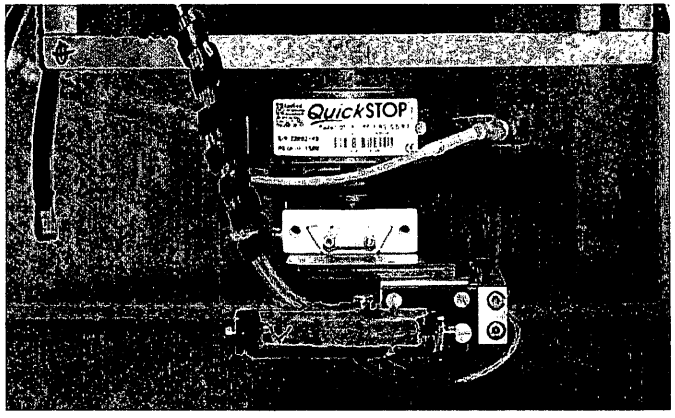




Elements of AIIS

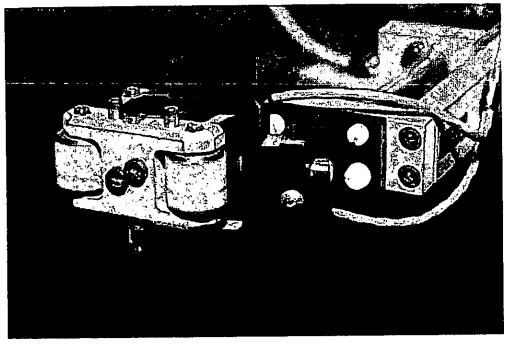
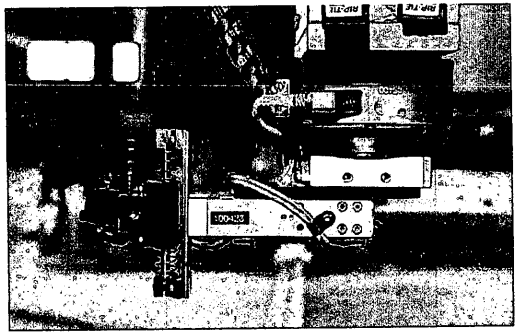
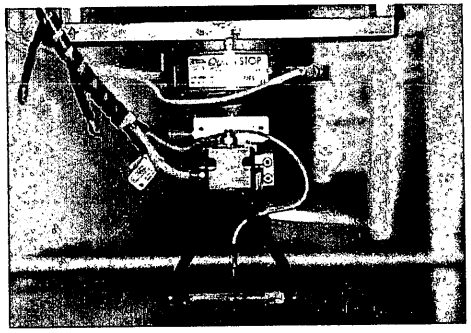
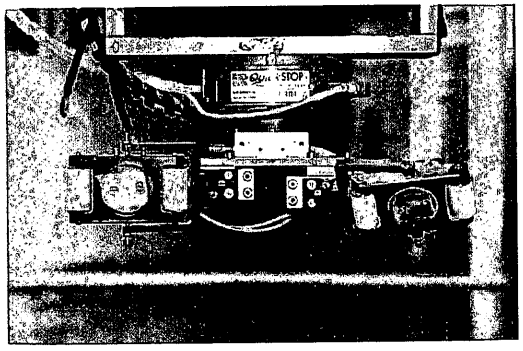
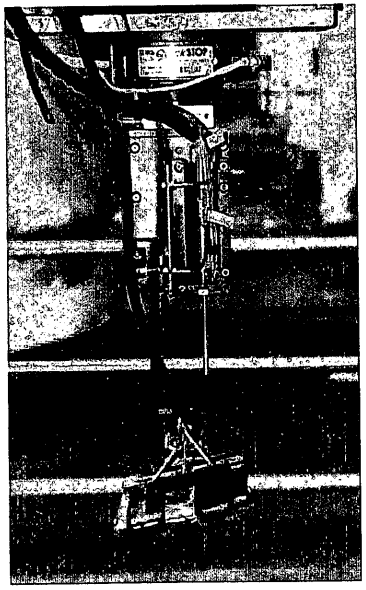
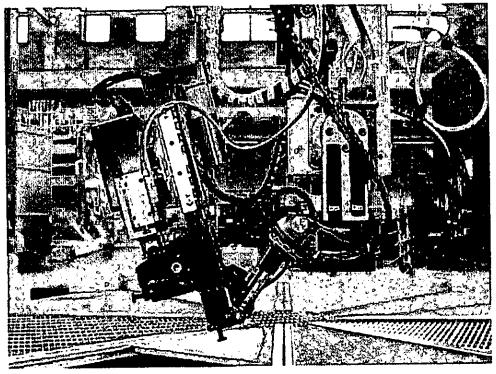
- Each component incorporates multiple "probe sleds" used to inspect different part geometries
- All sleds slide onto wrist using dovetail joint





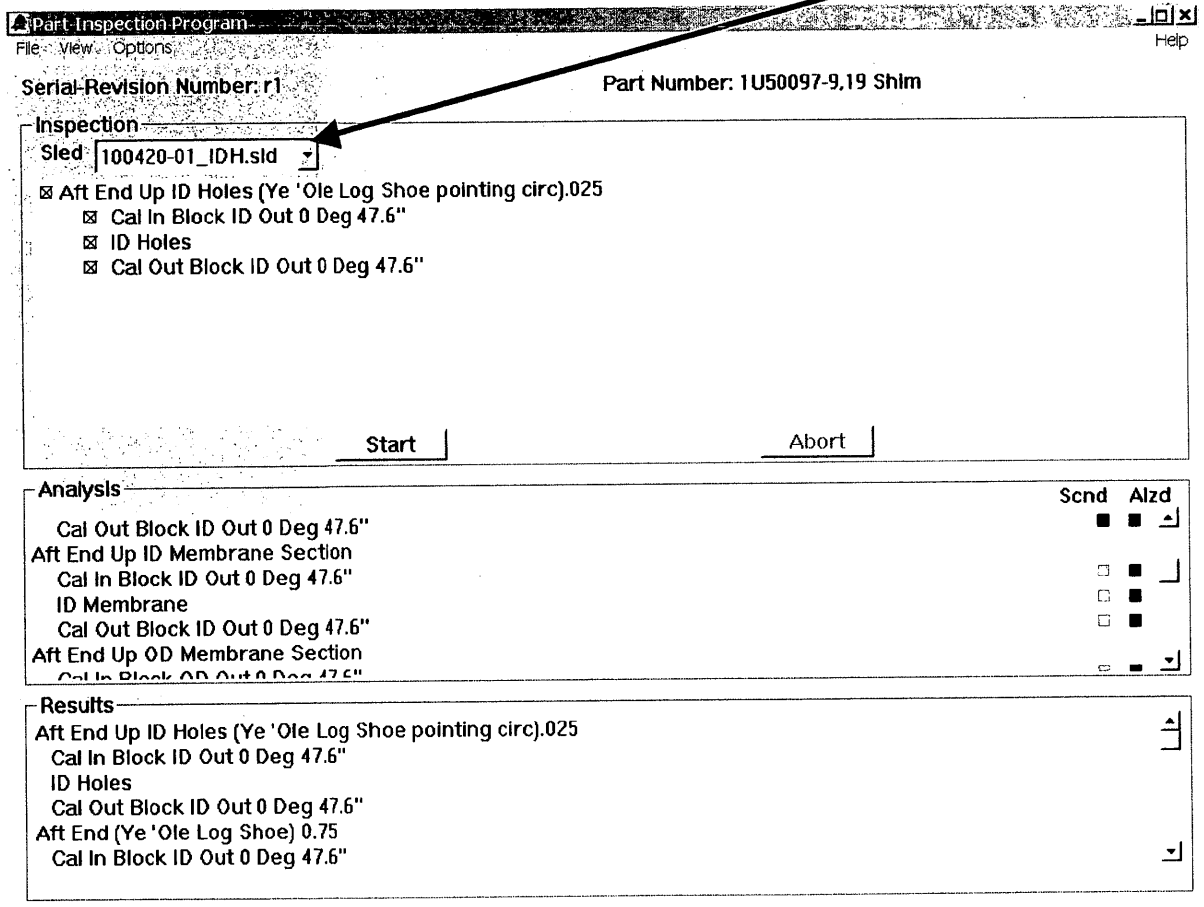
Elements of AIIS

Various Sleds

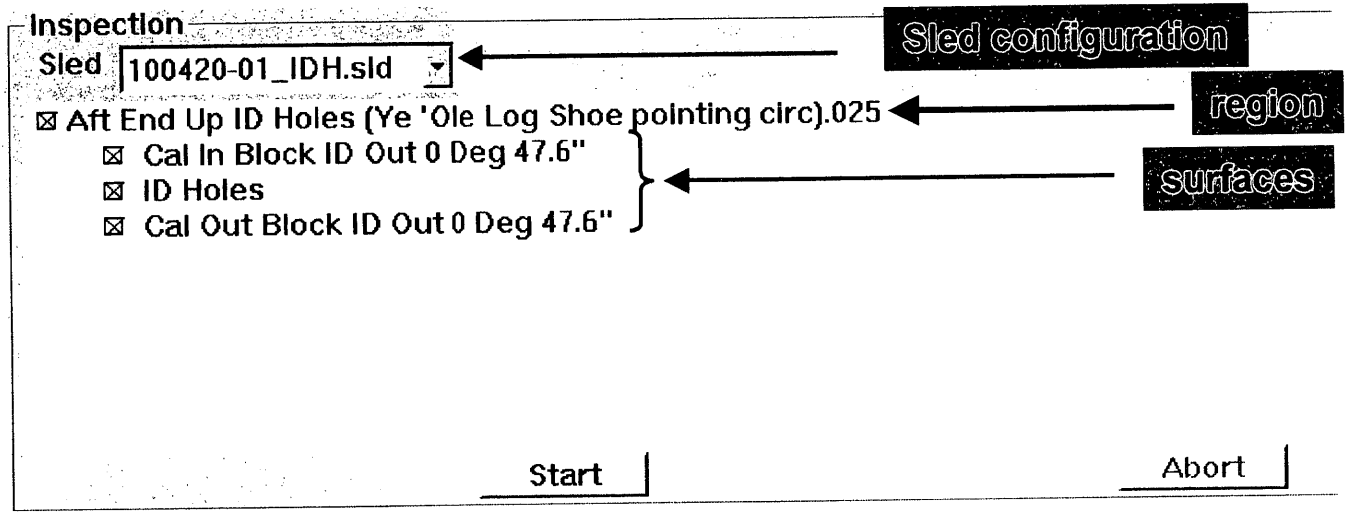
Elements of AIIS

- Operator interface: Part Inspection Program (PIP)
  - Operator selects part; then probe sled

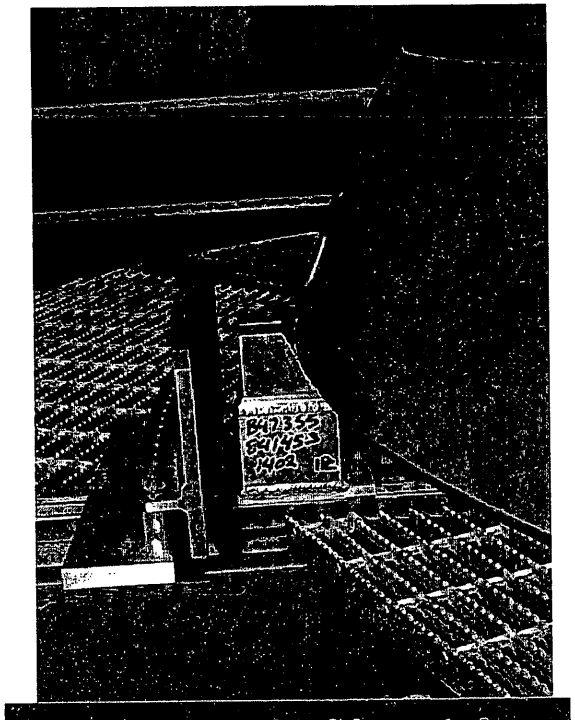


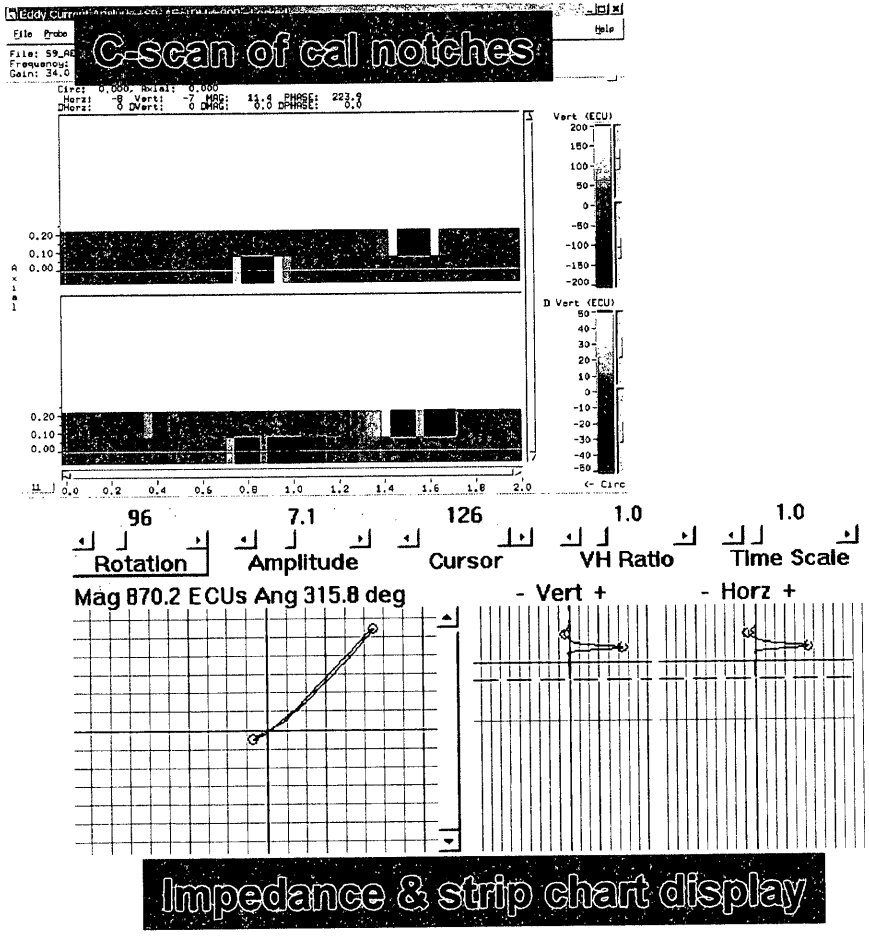
Elements of AIIS

- All regions and surfaces inspected with the sled are selected, and the AIIS inspects those surfaces
  - Each "region" starts & ends with a calibration scan



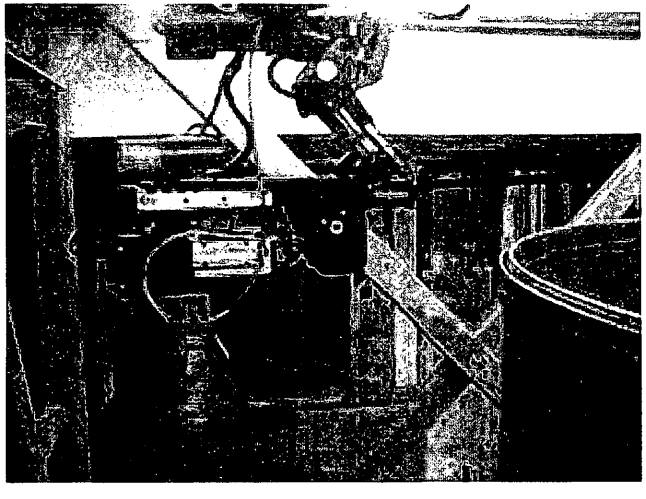
Elements of AIIS

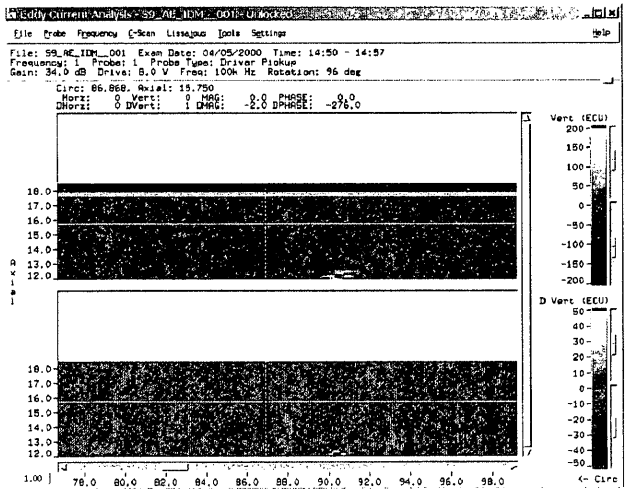




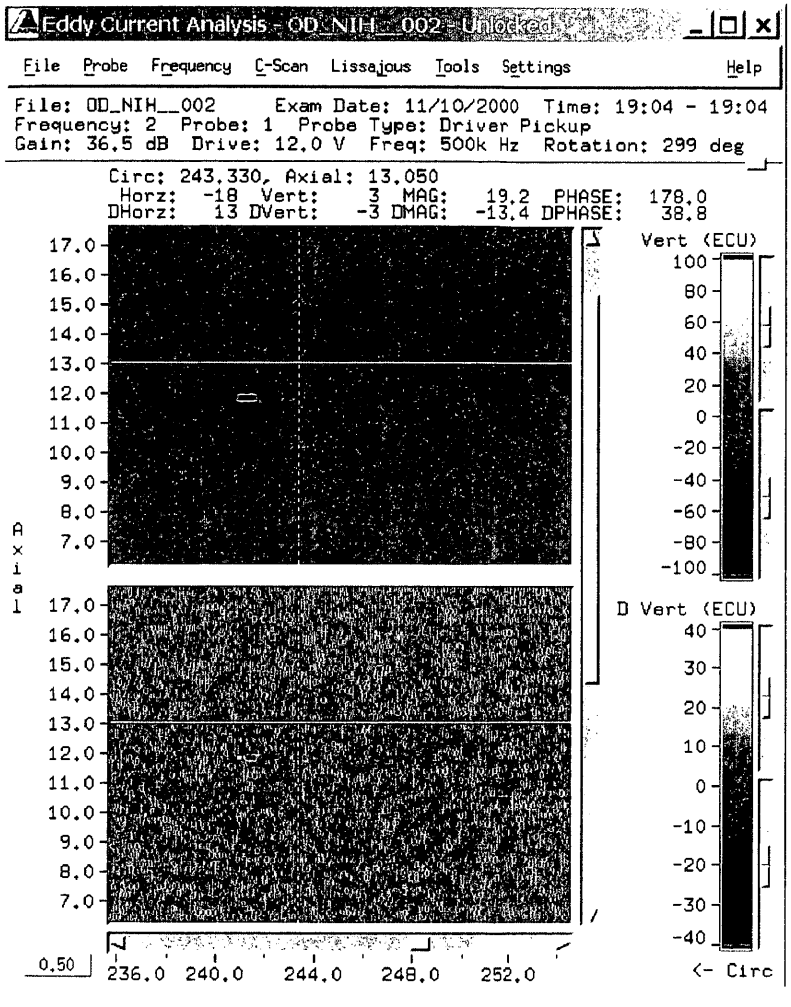
Elements of AIIS

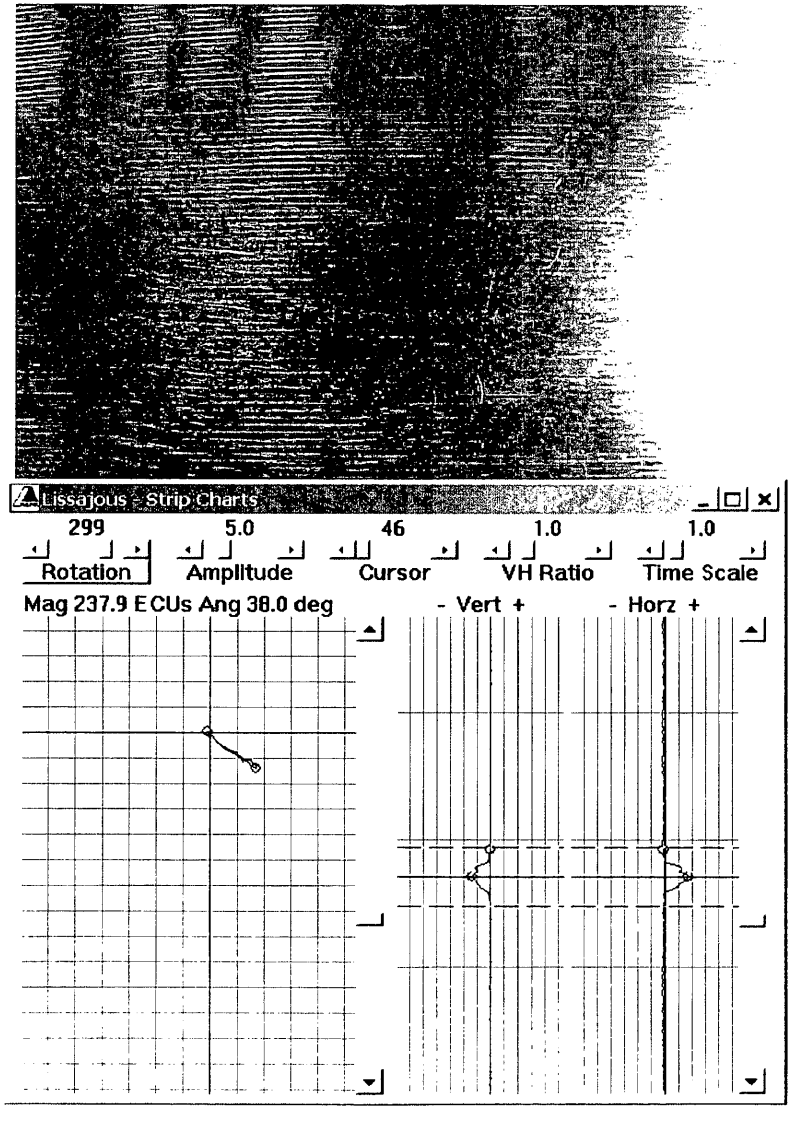
- Scan surface of interest





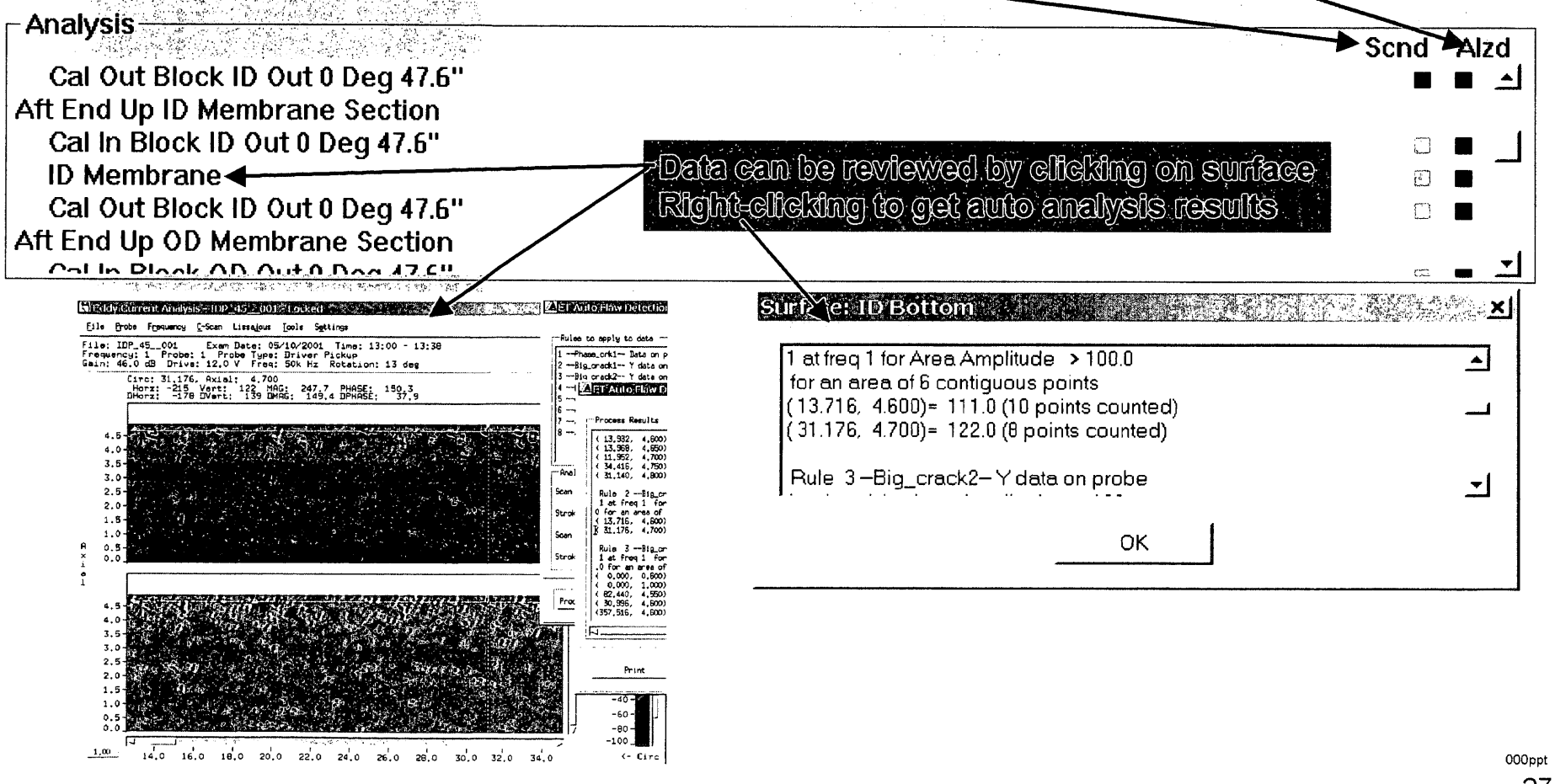
Elements of AIIS





Elements of AIIS

- PIP keeps track of data acquired and analyzed

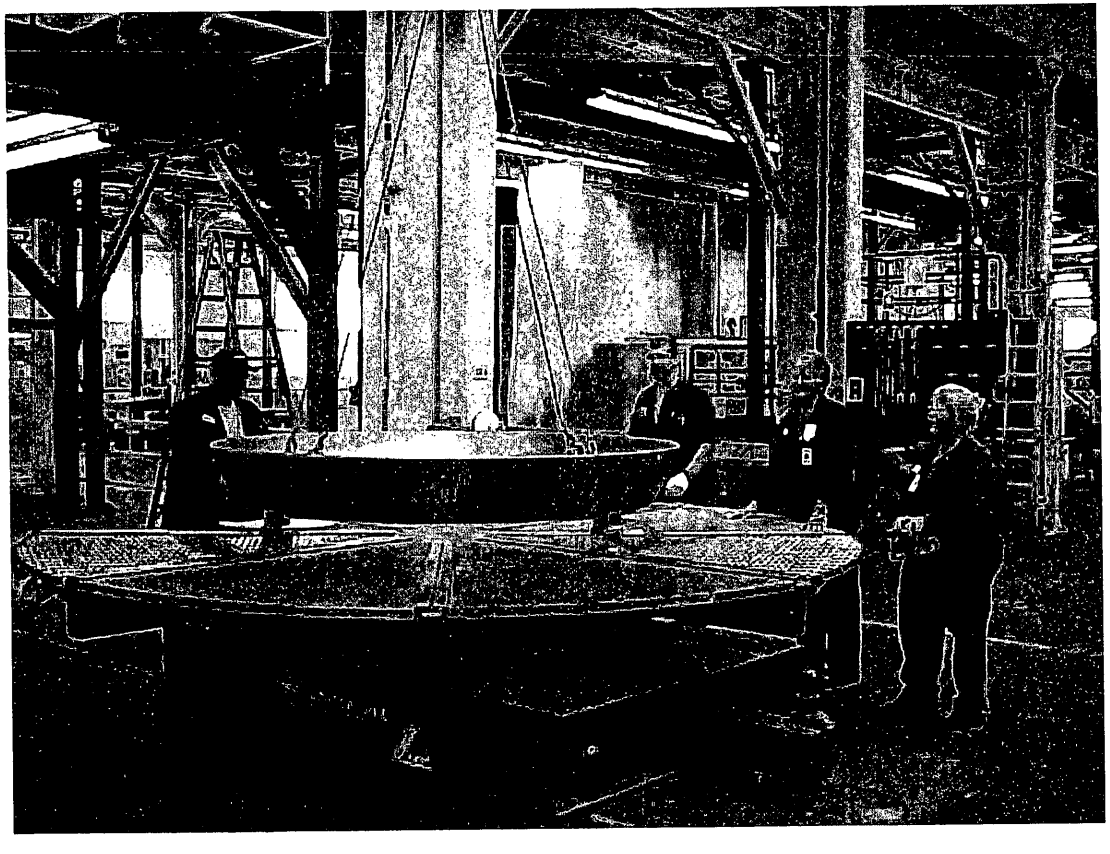


Elements of AIIS

- After all data is acquired, analysis results can be printed out
- All auto analysis findings are reviewed for final evaluation
- C-scan images are also independently reviewed by the operator in a pseudo real-time mode

Elements of AIIS

- Part is off-loaded and next part is loaded on



Current Status

- AIIS is now inspecting flight hardware concurrently with the certified NDE process (MT, PT, ET, UT)
- Once all qualification paperwork and approvals are obtained, the majority of the visual and manual inspections (MT, PT, ET) will be deleted
- Select areas that tend to more frequently have cracks will continue to be double inspected (AIIS & MT)

Concluding Statements

- ***An automated eddy current system has been designed and built, and is being implemented to inspect RSRM (Space Shuttle) metal components***
- ***The system provides a significant increase in inspection reliability, as well as other benefits such as data storage, chemical waste reduction and reduction in overall process time***